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May 29, 2013

**EX PARTE PRESENTATION**

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Ex Parte Presentation in WT Docket No. 12-69, *Promoting Interoperability in the 700 MHz Commercial Spectrum*

Dear Ms. Dortch:

Pursuant to Section 1.1206 of the Commission's rules, 47 C.F.R. § 1.1206, DISH Network Corporation ("DISH") submits this letter summarizing a meeting on Friday, May 24, 2013 with Tom Peters, Chief Engineer, Wireless Telecommunications Bureau; Charles Mathias, Assistant Bureau Chief, Wireless Telecommunications Bureau; Maria Kirby, Legal Advisor, Wireless Telecommunications Bureau; Paul D'Ari, Deputy Chief, Spectrum & Competition Policy Division, Wireless Telecommunications Bureau; Sanyal Paroma, Assistant Division Chief, Spectrum & Competition Policy Division, Wireless Telecommunications Bureau; Jennifer Flynn, Attorney, Spectrum & Competition Policy Division, Wireless Telecommunications Bureau; and Tom Tran, Engineer, Spectrum & Competition Policy Division, Wireless Telecommunications Bureau. Present on behalf of DISH were Jeffrey Blum, Senior Vice President and Deputy General Counsel; Mariam Sorond, Vice President, Technology Development; David Zufall, Vice President, Wireless Development; and John Kim, outside consultant.

During the meeting, DISH presented the attached technical report, which demonstrates that to the extent the Commission adopts 700 MHz interoperability rules, it can do so without changing the Lower 700 MHz E Block authorized power level (50 kW ERP). In the report, DISH compares the ground-level signal strengths resulting from two hypothetical Lower E Block deployments: (i) a high power broadcast deployment, and (ii) a lower power cellular base station deployment. DISH's analysis shows that, as the result of the strict ground-level power flux density (PFD) limits applicable to the E Block, a high power Lower E Block broadcast transmission causes less ground level signal than would a typical, lower power 1 kw/MHz base station transmission (such as an LTE signal) in the same block. The analysis demonstrates that a PFD-limited high power broadcast transmission in the Lower E Block is no more harmful to adjacent block operations than the lower power alternative. And, any parties requesting modification of the Lower E Block technical rules have provided no evidence that the existing rules are insufficient to protect adjacent operations. There is thus no technical justification to change authorized power levels in the Lower E Block in this proceeding, because these levels have no impact on the Commission's goal of promoting interoperability in the Lower 700 MHz band.

Respectfully submitted,

*/s/ Jeffrey H. Blum*

Jeffrey H. Blum

cc: Tom Peters
Charles Mathias
Maria Kirby
Paul D'Ari
Sanyal Paroma
Jennifer Flynn
Tom Tran

Attachment

# Lower 700 MHz E-Block Transmit Power & Ground-Level Signal Analysis

DISH Network Corporation

**The Commission's Study in 2001 Established Adequate Safeguards for 50 kW Blocks**

The technical rules for 50 kW ERP blocks were first formulated in the Lower 700 MHz Band Report and Order adopted in December 2001.[1] As summarized in the R&O, the Commission assessed the potential for interference from 50 kW stations to neighboring lower-power blocks, and established "specific requirements regarding non-interference."[2] Appendix D of the Report and Order provided an engineering analysis of the ground-level power flux density (PFD) surrounding a 50 kW broadcast tower, concluding:

> *"There are no practical difficulties achieving low PFD values with transmitting power levels greater than 1 kW. In fact, transmitting antennas in common use for television broadcasting have vertical radiation patterns that reduce the PFD on the ground near the antenna site to low values."*[3]

To safeguard adjacent operations, the Commission established a PFD limit of 3000 $\mu W/m^2$ at ground level within 1 km of the high power transmission tower,[4] and required construction notification to the Commission and adjacent licensees.

The PFD limit was an elegant solution to control adjacent channel interference. By establishing a PFD limit, the Commission ensured that signal levels on the ground would remain at or below levels similar to those radiated by lower-power base stations mounted at lower antenna heights. The 50 kW licensees were given the responsibility to adhere to the ground-level PFD, and the flexibility in how to achieve that requirement. The ground-level power depends greatly on three factors: the transmit power at the antenna port; the antenna gain toward the ground; and the antenna height above the ground.

A high power transmission will not interfere with adjacent channels if the antenna is mounted at a sufficient height. The broadcast signal spreads out with distance, reducing the energy within a given area. This is the principle behind the PFD – the limit defines the permitted power level at the ground. The operator must plan the antenna selection and height to ensure sufficient signal spreading at ground level. The Commission's approach provided the degrees of freedom necessary to enable new broadcast business models as well as to adequately protect adjacent licensees.

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[1] Report and Order, Reallocation and Service Rules for the 698-746 MHz Spectrum Band (Television Channels 52-59), GN Docket No. 01-74, adopted December 12, 2001.
[2] R&O, at 102.
[3] R&O, D-1 at 2.
[4] FCC Part 27.55 (b).

**Lower 700 MHz Paired Blocks May Generate Higher Ground-Level PFD Values**

The Lower 700 MHz base station blocks are permitted to transmit with power levels up to 1000 W/MHz ERP.[5] If certain other conditions are met such as a notification requirement and a PFD limit, the Lower 700 MHz base stations are permitted to transmit at levels greater than 1000 W/MHz.[6]

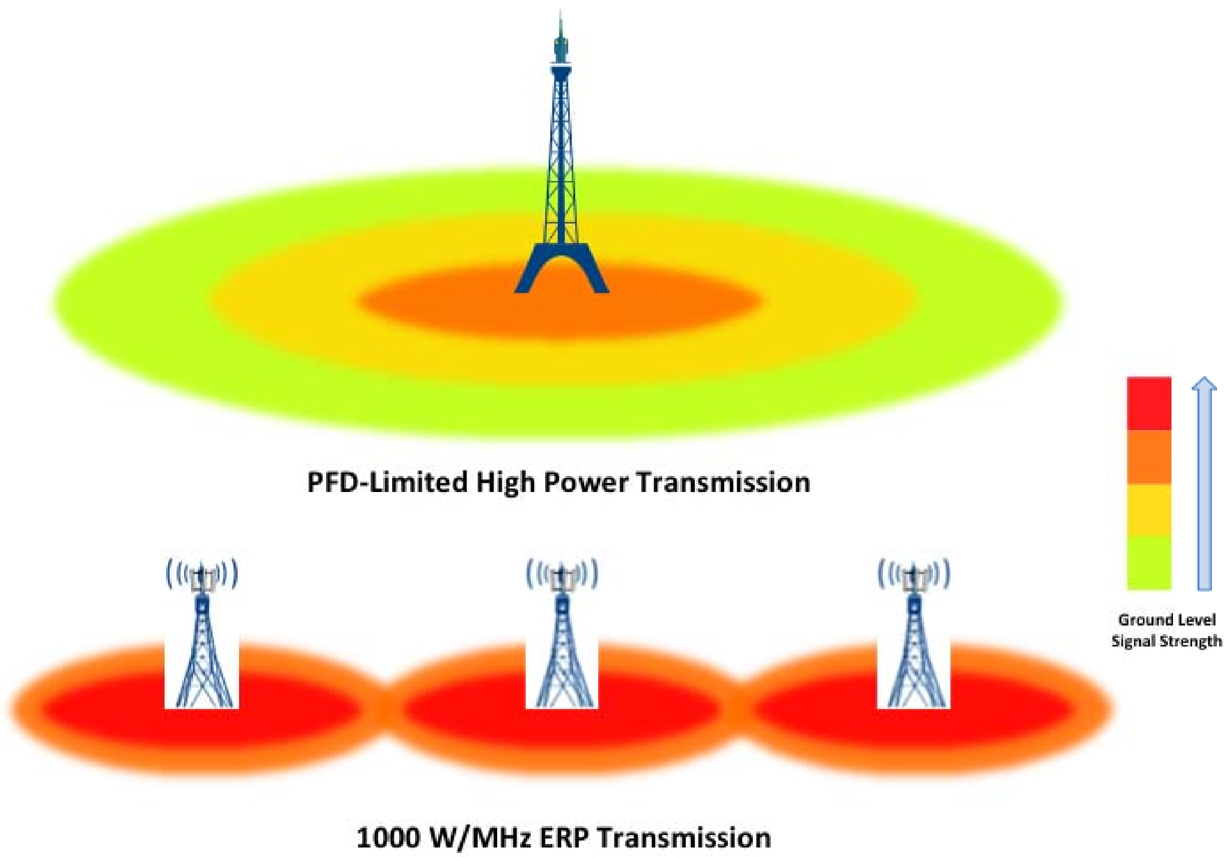


**Figure 1. PFD-Limited High Power Transmission vs. Unrestricted Low Power Transmission**

Base station antennas are typically mounted at heights of 40 meters or less. The closer proximity to the ground results in reduced spreading loss – the ground-level signal from a 40 meter tower will be stronger than from a 150 meter tower. A second factor impacting the ground-level signal strength is the antenna pattern. At the lower antenna mounting height, a base station's peak antenna gain will reach the ground at a point closer to the tower than

[5] FCC 27.50 c (3).
[6] FCC 27.55 b.

would a broadcast antenna pattern mounted several hundred meters above the ground. Broadcast stations attempt to cover large distances from a single tower, and focus the antenna gain toward the horizon. The energy reaching the ground within 1 km of the broadcast tower is no different than the energy from a base station, as depicted in Figure 1 and theoretically derived below.

**PFD-Limited Lower E Block Ground-Level Signal is Similar to Other 700 MHz Block Ground-Signal Level**

We present an analytical study to show that ground-level signals from a 50 kW E Block deployment would be similar to the ground-level signals from a typical base station deployment in the Lower E Block, or for that matter, in the Lower A, B, C or Upper C Blocks. In fact, our analysis shows that higher ground-level signals will result with the latter case.

As indicated above, the FCC rule allows full 50 kW ERP transmission at the Lower 700 MHz E Block only if the PFD caused by the transmission is limited to 3000 $\mu W/m^2$ at any location at ground level within 1 km of the transmitting tower. If the antenna height cannot be adjusted to meet the stated PFD requirement at full 50 kW ERP, then the transmit power level must be reduced. The PFD is calculated

$$PFD = \frac{EIRP}{4\pi D^2} = \frac{1.64ERP}{4\pi D^2}$$

where *D* is the distance between the antenna and the measurement point. For high powered broadcast transmission, a ground reflection factor of 1.6 should be considered[7], and therefore,

$$PFD = \frac{2.56EIRP}{4\pi D^2} = \frac{1.05ERP}{\pi D^2}$$

Figure 2 shows the vertical patterns of several commercially available high power broadcast antenna models from Dielectric. These antennae were installed and used at DISH's recent E Block trial sites. Unless noted otherwise, Model TLP-12A (with 10.8 dBd gain) is used as the default high power antenna model for our analysis. We include results from the other antenna

[7] FCC OET Bulletin 65

models as necessary in order to show that the findings/observations from the proceeding analysis are applicable to other high power antenna models.

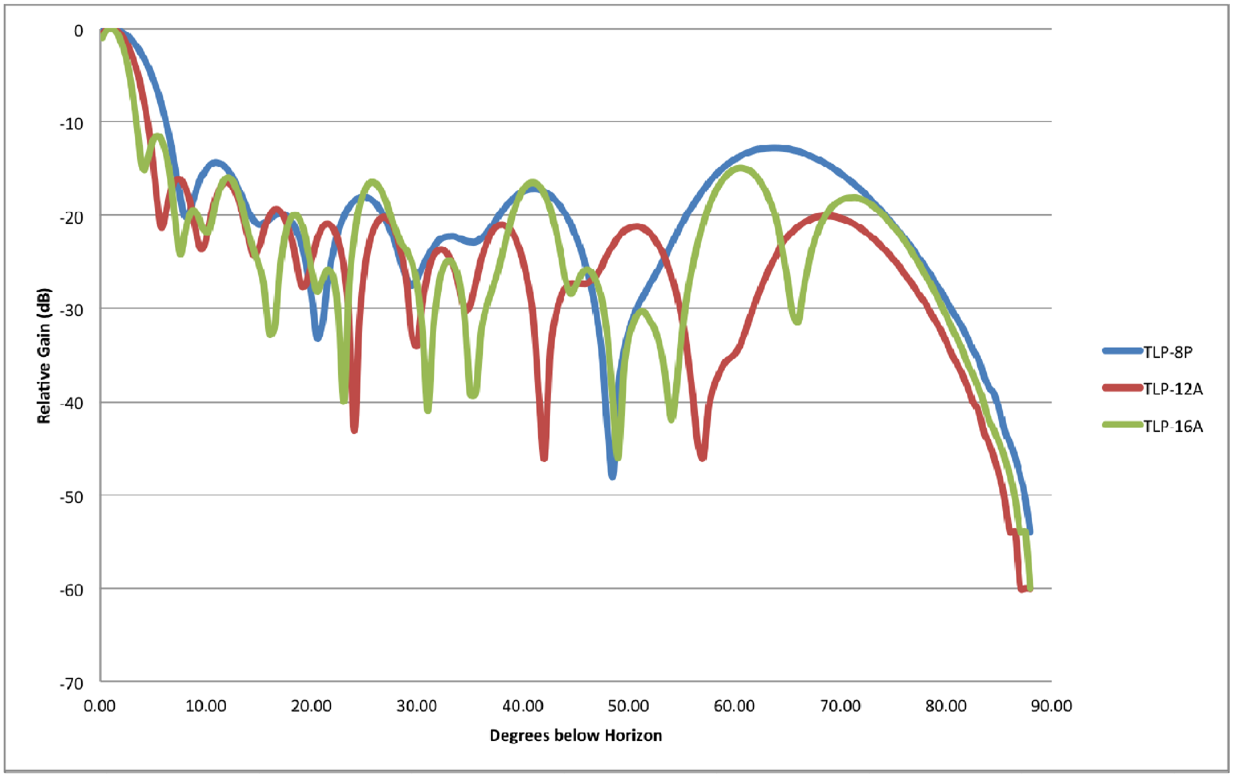


**Figure 2. Dielectric Broadcast Antenna Vertical Gain Patterns w/ 1 degree tilting**

Figure 3 shows the predicted PFD level as a function of the distance from a tower with 150 m antenna height transmitting at full 50 kW ERP (the blue curve).

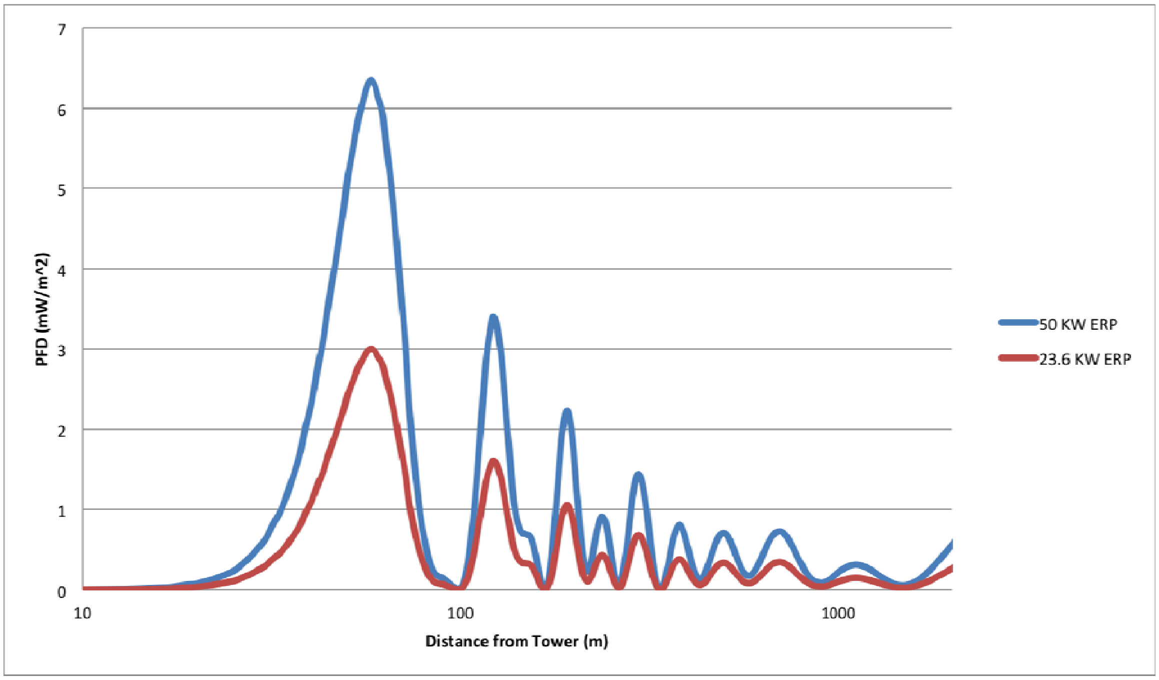


**Figure 3. Distance vs. PFD with 150 m Antenna Height**

With the default antenna pattern, the theoretical analysis suggests that full 50 kW ERP transmission from a 150 m antenna height may exceed the 3000 $\mu W/m^2$ PFD limit. In such a case, if the antenna height cannot be increased at the tower, then the transmit power level should be reduced, at minimum, to 23.6 kW ERP to remain within the PFD limit (the red curve).

Figure 4 shows the PFD-limited transmit power level as a function of antenna height for the default antenna pattern. Our analysis shows full 50 kW ERP transmission is possible at antenna heights greater than ~ 220 m.

Figure 5 shows the on-ground signal levels from various Lower E Block high power antenna heights. For this analysis, the free space LOS propagation model is used. Two important observations can be made from the figure. First, the PFD limit proves to be an effective mechanism for controlling potential interference from high power Lower E Block transmissions. We note that the ground-level power does not exceed the regulated level under a variety of operating conditions, providing flexibility to the E Block operator in how best to achieve the broadcast coverage.

Second, the greatest signal levels are observed at locations very close to the transmitting site (< 200 m). This observation is intuitive since spreading loss rapidly diminishes the ground-level power. Broadcast stations mounted on towers several hundred meters tall are generally located in relatively isolated areas, reducing the probability that a mobile device receiving in nearby spectrum would closely approach the E Block tower.

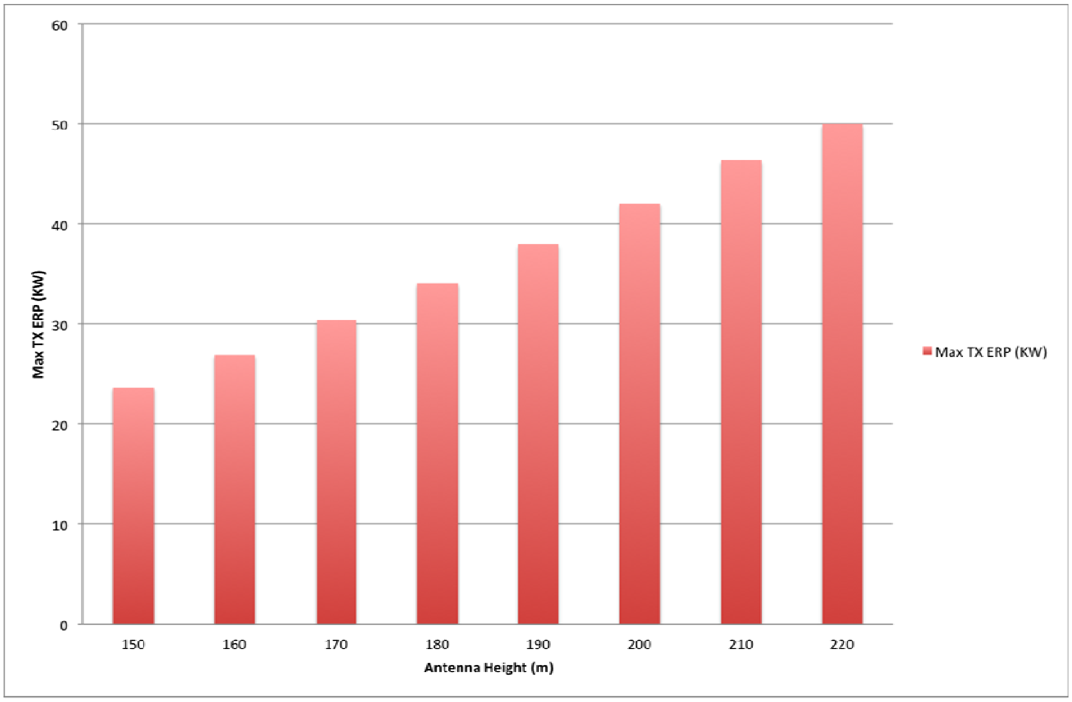


Figure 4. Antenna Height vs. Maximum Allowed ERP Level

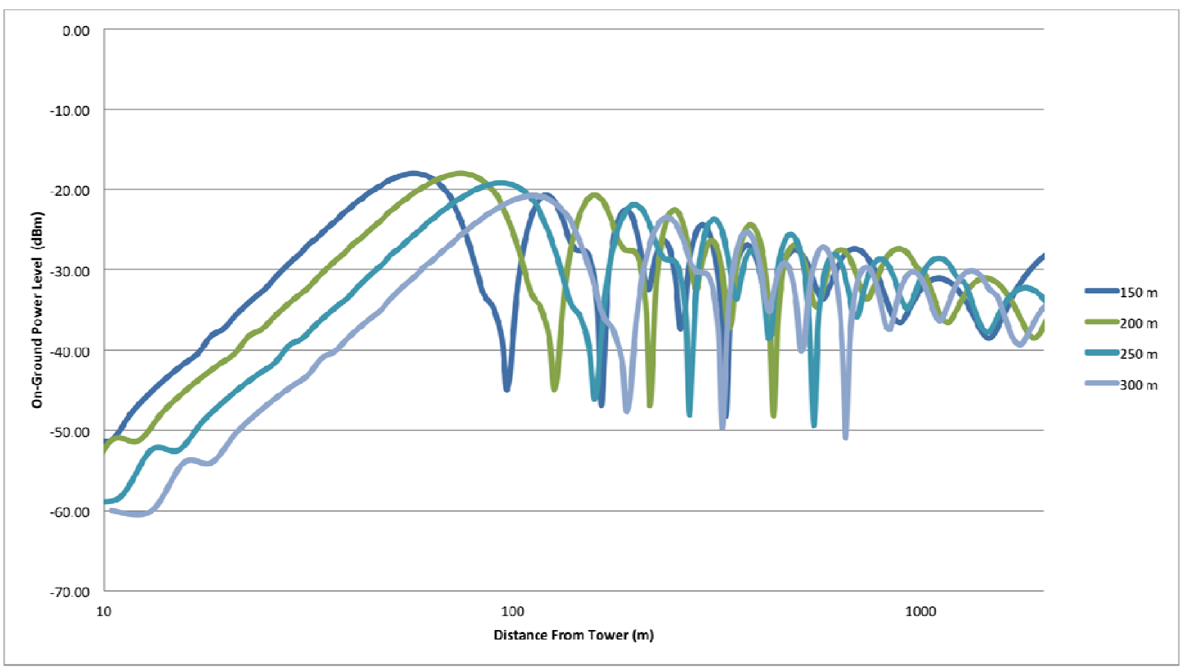


Figure 5. Ground-Level Power Versus E Block Antenna Height

Figure 6 compares the on-ground signal levels from the three high power broadcast antenna models mounted at 150 m high. Although the models exhibit different gain patterns, as shown in Figure 2, they are equally subjected to the PFD limit and yield similar on-ground signal levels accordingly.

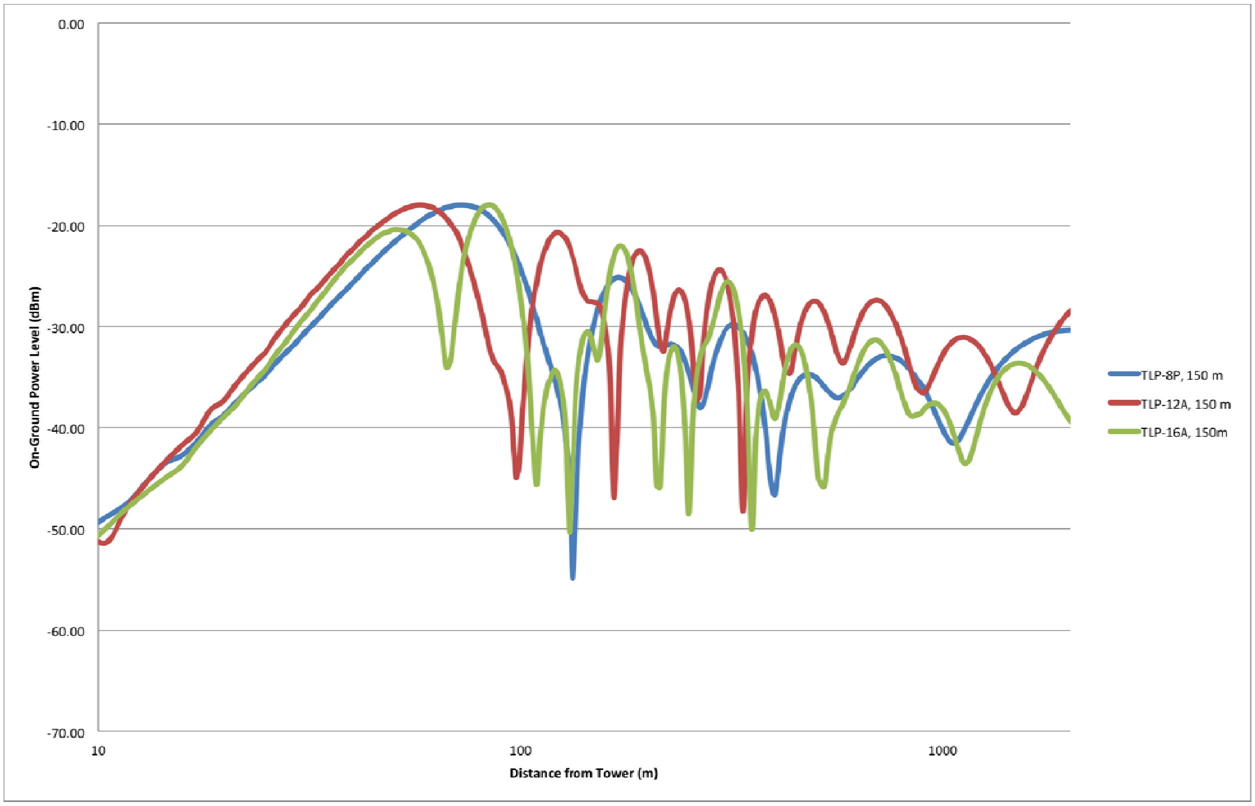


**Figure 6. Ground-Level Power Versus E Block Antenna Model**

We now analyze the received signal level from a hypothetical lower power E Block base station transmission. The FCC rule permits up to 1 kW/MHz ERP in general for the Lower 700 MHz blocks and we consider a 5 MHz carrier in our analysis. We use a 700 MHz base station antenna model from Commscope (Model LNX-6512DS-VTM)[8] and consider typical macro antenna down-tilt configurations of 5 and 10 degrees. The vertical antenna gain patterns of the two down-tilt configurations are shown in Figure 7.

[8] http://www.commscope.com/catalog/andrew/product.aspx?id=76&searchBSA=true

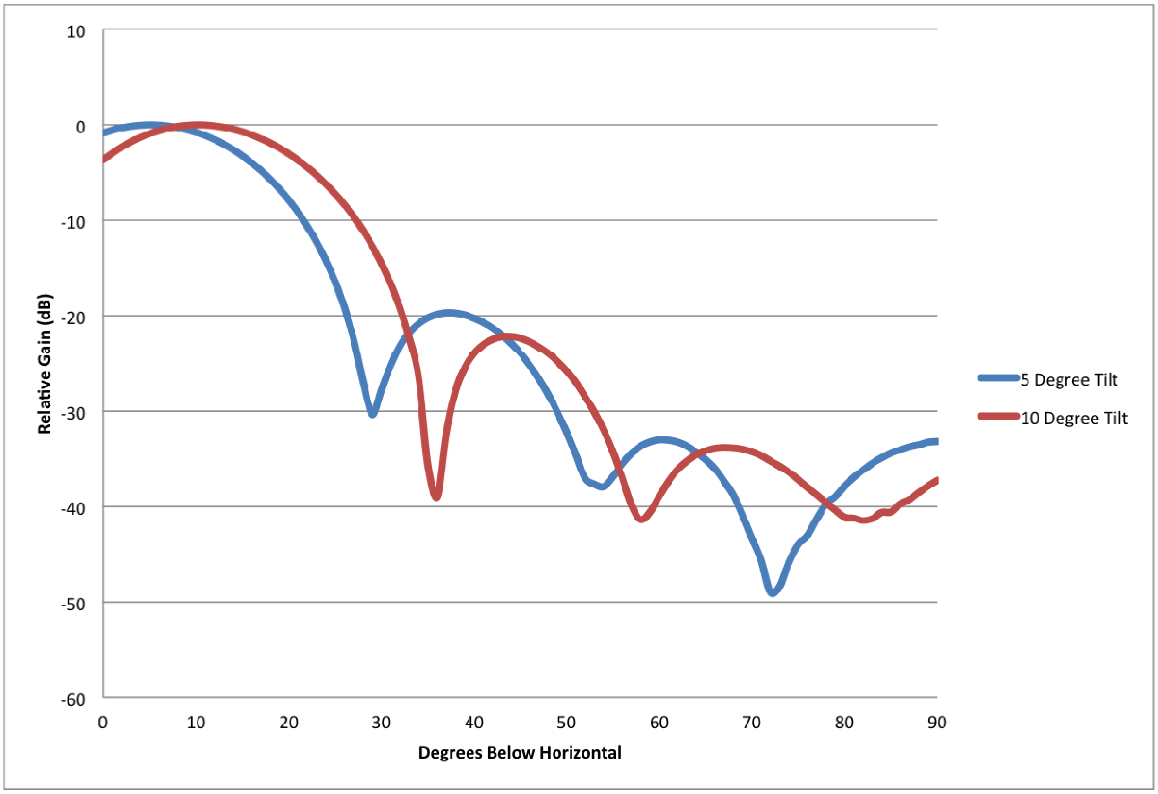


**Figure 7. Commscope LNX-6512DS-VTM Antenna Vertical Gain Patterns**

Figure 8 compares the received signal strength from a base station transmission at 40 meters versus a 150 meter high-power transmission. For this comparison, the mobile device height and device antenna/body loss are assumed to be 1.5 m and 8 dB, respectively. The TM91-1 propagation model is used for the base station case, while the free-space LOS model is used for the high power transmission. The analysis clearly shows that, even with the conservative LOS assumption for the high transmission case, the base station generally produces a stronger ground-level signal within 1 km of the tower. As noted by the Commission, the PFD rule adequately controls ground-level E Block power to levels which are similar or less than those from an E Block base station.

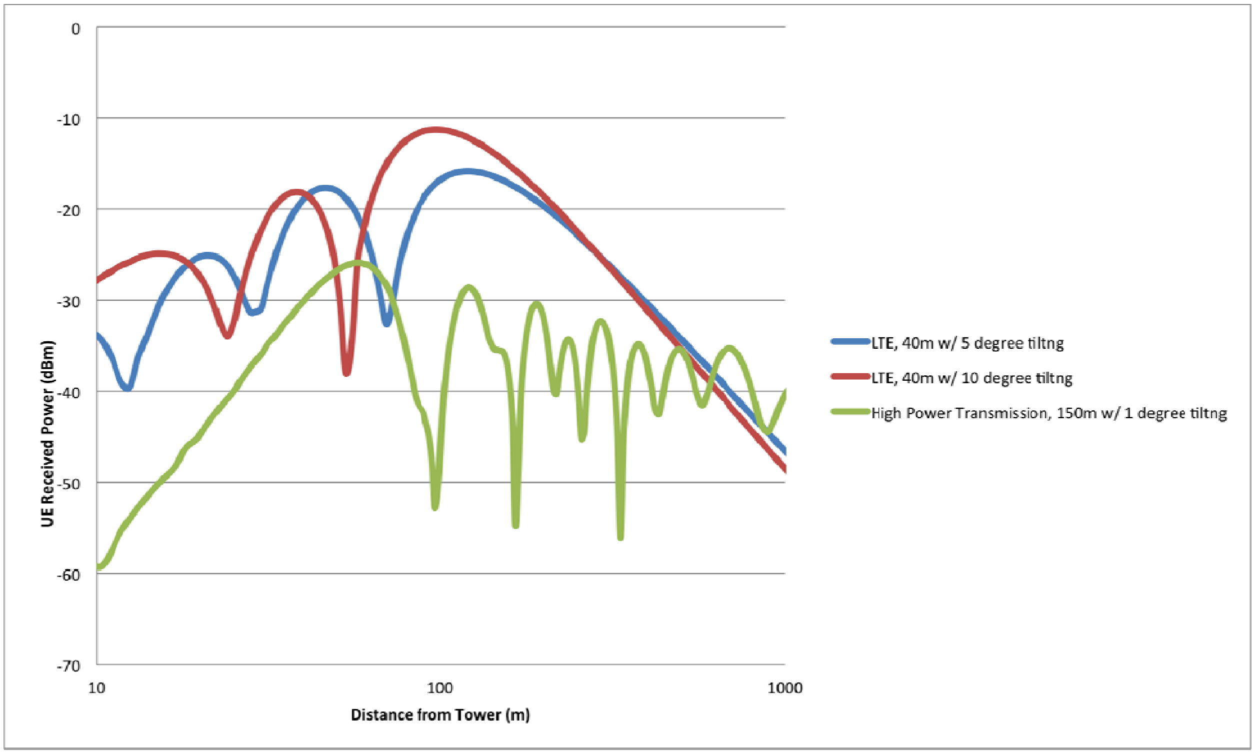


**Figure 8. Received Signal Comparison Between 40 m Base Station Transmission vs. 150 m High Power in Lower E Block**

Similar observations are made when other propagation models are applied to the analysis. For example, Figure 9 shows our analysis based on the COST231-Walfisch-Ikegami model. The COST231-Walfisch-Ikegami model is used because it supports both LOS and NLOS propagations and is valid for propagation distances down to 30 m[9]. The LOS model is applied to the high power transmission case, while the low power base station transmission is subjected to the NLOS model. Table 1 shows the specific NLOS related parameters used in our analysis.

| Parameter | Values |
|---|---:|
| UE Antenna Height | 1.5 m |
| Roof Heights | 10 m |
| Street Width | 20 m |
| Building Separation | 30 m |
| Road Orientation | 90 degrees |

**Table 1. COST231-Walfisch-Ikegami Parameters**

[9] G. L. Stuber, "Principles of Mobile Communication," 2nd Ed, Kluwer Academic Publishers

Figure 9 shows our COST231-WalFisch-Ikegami based received signal level comparison at various antenna height configurations. The result is consistent to the preceding TM91-1 based analysis in that the high power broadcast transmission presents less ground-level energy to adjacent channel operations than its lower power, lower height counterpart. Our analysis validates that the FCC's current PFD limit on high power operation on the lower 700 MHz E Block is indeed an effective interference mitigation measure.

The validity of our analysis is further reinforced by the fact that we have applied aggressive LOS propagation assumptions on the high power transmission case in order to provide a "worse case" scenario. For the same reason, we also have not considered polarization in our high power transmission analysis. In the prior DISH trial deployments, half of the 50 kW ERP is transmitted with vertical polarization and half with horizontal polarization. Energy within the two orthogonal polarizations is not directly additive. This dual-polarization technique improves broadcast signal reliability throughout the coverage area, but does not add constructively in an interference situation. Thus, the above power results for 50 kW are inflated to twice the level which would occur in a regular deployment.

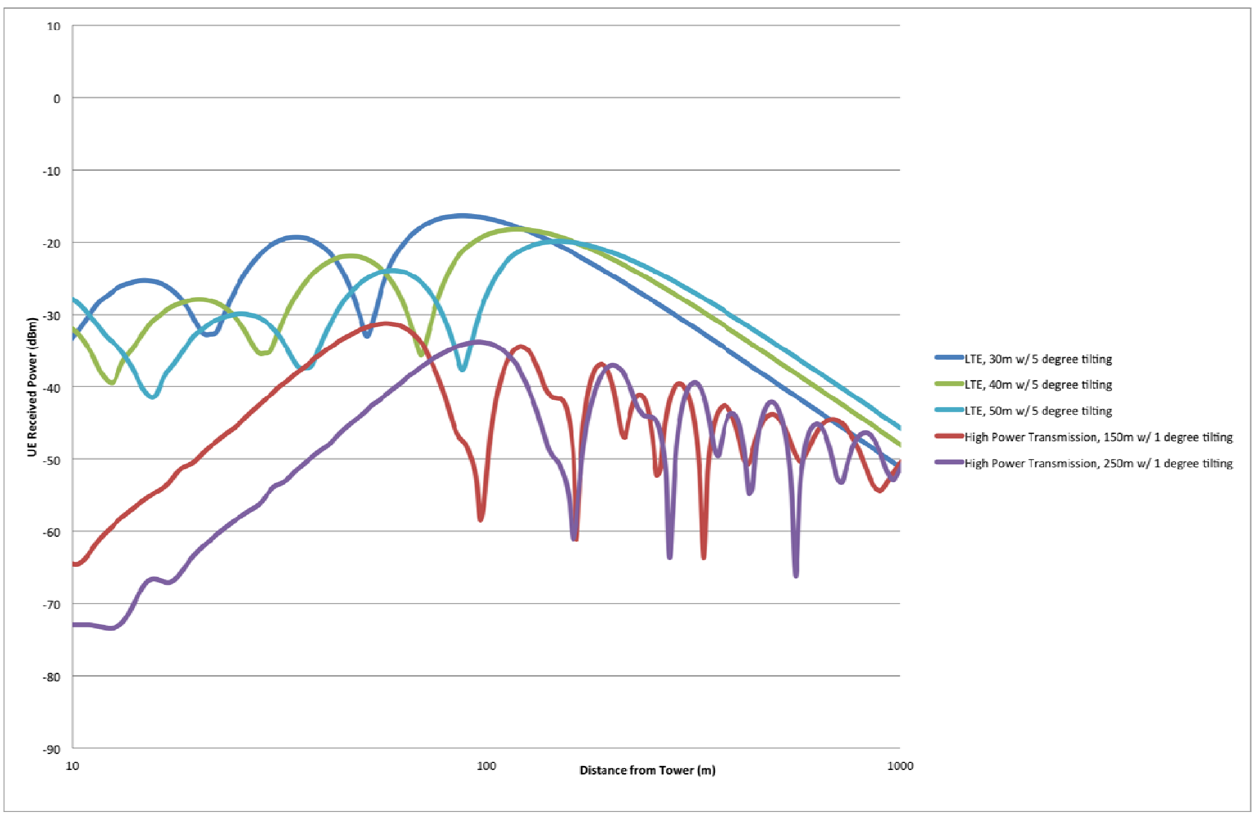


**Figure 9. Cost231-Walfisch-Ikegami based received signal level comparison**

This analysis supports the Commission direction of specifying a PFD limit for high power transmission in the Lower 700 MHz Band – the Lower E Block ground-level power is similar to or less than that of a typical base station and would not cause interference to adjacent channel operations.  As the Commission concluded in 2001, "under appropriate regulations, a 50 kW ERP limit can be permitted without causing harmful interference among adjacent channel broadcasting and wireless operations."[10]

**Before Auction 73, AT&T Agreed That 50 kW ERP Would Not Cause Interference**

In 2006, the Lower 700 MHz technical rules were once again opened to review and comment in preparation for Auction 73.  In their comments dated October 2006, AT&T recommended that the Commission maintain the 50 kW ERP limit established for some blocks in the Lower 700 MHz Band, concluding that "the Commission, therefore, should continue to promote efficient usage of this spectrum and optimize consumer benefits by maintaining this existing limit." [11]

Later in their reply comments, AT&T raised the possibility of receiver overload or out-of-band emissions interference between 50 kW and 1 kW operations, but noted:

> *"The mobile industry has long experience with these interference issues in the cellular and PCS bands, and has evolved handset designs and operational models to mitigate these issues."*[12]

AT&T's final conclusion was that a 1 MHz guard band would be sufficient to avoid the interference issues - a criterion they felt would be met by maintaining a then-existing 1 MHz A Block guard band between the now-present Lower C Block and Upper C Block.[13]

The record fully supports the integrity of the 50 kW ERP for the Lower E Block.  The Commission began deliberations on the suitability of 50 kW ERP blocks in 2001, seven years before Auction 73.  As of 2007, AT&T fully supported 50 kW power levels in the band.

Further, it is important to note that no engineering details changed from 2007 to 2008 when AT&T requested a separate Band Class 17.  The general 3GPP in-band blocking requirements for LTE are identical to those of UMTS, which was the predominant 3GPP technology during the

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[10] R&O, at 111.
[11] Comments of AT&T Inc. in the Matter of Service Rules for the 698=746, 747-762 and 777-792 MHz Bands, WT Docket No. 06-150, October 5, 2006, II.
[12] Reply Comments of AT&T, June 4, 2007, WT Docket No. 06-150, p. 27.
[13] Reply comments, p. 28: "Thus, the [1 MHz A Block] guard band is necessary to protect the services of each of these bands."

2001-2007 period. Any technical concerns about device interference could have been raised at any point in the seven-year period prior to Auction 73. No objections were raised by AT&T beyond the request for a 1 MHz guard band.

In 2010, 3GPP established a 1 MHz guard band between the Lower E Block and the Lower A, B and C Blocks, from 728-729 MHz.[14] AT&T's pre-auction stipulations regarding management of potential interference between the 50 kW Lower E Block and neighboring lower-power blocks have been met through prior Commission action and 3GPP Band 12 definition. There is no demonstrated need to modify the Lower E Block allocated ERP.

**In Conclusion, High Power Lower E Block Transmission is Properly Sanctioned by the Current PFD Rule and Would Not Produce Greater Ground-Level Signal than 1 kW/MHz Transmission in the Block**

We have presented a comprehensive analysis showing that PFD limited high power Lower E Block transmissions produce ground-levels signal similar to those of normal Lower 700 MHz Paired Block transmissions. In fact, our analysis has shown that low power/height base station transmissions in the Lower E Block would produce higher ground-level signals than their PFD limited high power/height broadcast counterparts. Our analysis is based on commercially available 700 MHz broadcast and base station antenna patterns and applies various propagation models to cross-validate our observations. As clearly observed in our analysis, the FCC has the correct foresight when allowing high power transmission on Lower E Block and preempted potential adjacent interference issues by imposing a strict PFD rule on the high power transmission. The bottom line is that a high power Lower E Block transmission is no worse an interferer to adjacent block operations than a typical 1 kw/MHz transmission in the Block.

**Engineering Measurements in an Operational LTE Market Demonstrated that a 50 kW Lower E Block Will Not Cause Interference**

DISH partnered with Lower A Block operators in 2011 to measure Lower E Block ground-level power in Atlanta, Georgia, and to compare the measured levels to those from the commercial AT&T and Verizon Wireless LTE systems. The DISH subsidiary, Manifest Wireless, had deployed four high-power broadcast stations to cover the Atlanta metropolitan area. Simultaneous measurements of the Lower E Block signal and the Lower B+C and Upper C Block LTE signals enabled an impartial comparison of the ground-level energy present from all systems.

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[14] 3GPP TSG-RAN WG4 Meeting #57, R4-104458 Change Request: Correction to Band 12 frequency range, Jacksonville, FL, USA, 15-19 November 2010.

The Lower A Block consortium filed the measurement results with the Commission in May 2012. The report's conclusions agree with the theoretical analysis performed by the Commission pre-auction:[15]

> "The testing also confirmed that commercial devices are designed to far exceed the minimum 3GPP performance criteria in order to ensure compliance with specifications and adequate operation in markets with neighboring LTE systems in place. Band Class 17 devices currently receive and manage interfering signal levels from within the Lower B, C, and Upper C Blocks that are similar in strength to the Lower E Block broadcast signals. Devices designed to tolerate these neighboring LTE base station signals are also capable of handling the Lower E Block signals measured in Atlanta."

Thus, measurements of operational systems in Atlanta confirmed the Commission's 2001 analysis indicating that a power flux density limit provided sufficient protection to adjacent licensees from a 50 kW station.

The few entities requesting modification of the Lower E Block technical rules have provided no evidence whatsoever that the existing rules are insufficient to protect adjacent operations. To the contrary, all analysis and measurements based on realistic LTE device performance have demonstrated that 50 kW stations may successfully coexist with adjacent LTE operations. There is no demonstrated need to modify the Lower E Block technical rules.

[15] Cavalier Wireless, LLC, C Spire Wireless, Continuum 700 LLC,, King Street Wireless, L.P., MetroPCS Communications, Inc., US Cellular, and Vulcan Wireless ex parte filing of a technical paper authored by Doug Hyslop and Paul Kolodzy, "Lower 700 MHz Test Report: Laboratory and Field Testing of LTE Performance near Lower E Block and Channel 51 Broadcast Stations", p. 4.